

POLLINATION IN ALFALFA

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(WITH FIVE FIGURES)

The problem of fertilization in alfalfa has been a matter of considerable controversy for several years. Many experiments have been performed in endeavoring to determine what factor is most largely responsible for pollination in this plant. In the review of investigations published by PIPER, EVANS, MCKEE, and MORSE¹ it is stated that the amount of self-pollination varies with the season, and that its real importance in seed production is doubtful. HILDEBRAND² is cited as having believed as early as 1866 that fertilization may take place in untripped flowers, and URBAN³ (1873) is referred to as thinking that in some cases untripped flowers form pods. Most of the work of recent investigators has consisted of attempts to determine the most important agents in tripping the alfalfa blossom. Although a considerable number of experiments have been carried on, no definite conclusions seem to have been reached. ROBERTS⁴ found anthers dehiscing and stigmas pollinated in the early bud stages of the alfalfa.

An investigation which was begun by the writer during the latter part of September 1916, and which was continued until killing frosts in October, had for its object the determination of the stage at which the stamens of the majority of alfalfa flowers really shed their pollen. It was found that light frosts do not seem to have any effect upon pollination, the percentage of pollinated to unpollinated flowers not being affected so far as could be noticed in any of the classes of buds examined.

¹ PIPER, C. V., EVANS, M. W., MCKEE, R., and MORSE, W. J., Alfalfa seed production; pollination studies. Bull. 75. U.S. Dept. Agric. 1914.

² HILDEBRAND, F., Über die Vorrichtungen an einigen Blüthen zur Befruchtung durch Insektenhülfe. Bot. Zeit. 24:75. 1866.

³ URBAN, I., Prodrömus einer Monographie der Gattung *Medicago*. Verhandl. Bot. Ver. Provinz Brandenburg 15:13. 1873.

⁴ ROBERTS, H. F., Alfalfa varieties, breeding, seed, and inoculation. Quarterly Rept. Kans. State Board Agric. 35:180. 1916.

The flowers were divided arbitrarily into four classes, according to the stages of their development, as follows: straight bud, fig. 1; pointed bud, fig. 2; hooded bud, fig. 3; and erect standard, fig. 4. The lengths of the flower in millimeters were determined before they were examined, and these measurements serve to some extent as checks on their stages of development. In the fourth class of blossoms, the flowers did not measure longer than in the hooded bud

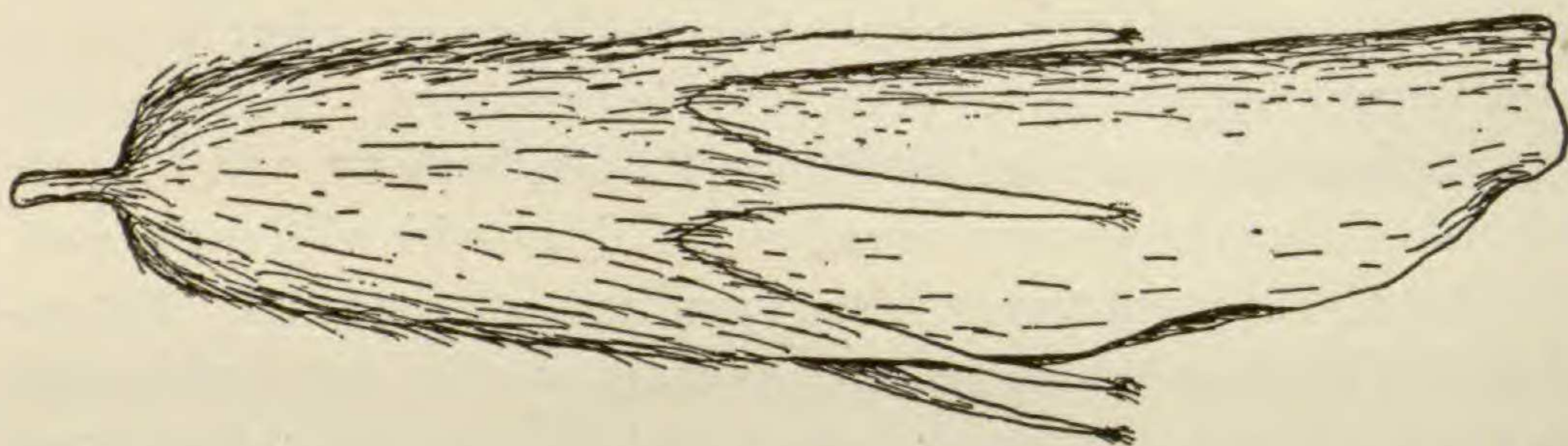


FIG. 1.—Alfalfa bud representing "straight bud" stage; corolla in this stage has not grown out much beyond calyx; only standard petal can be seen; it is folded around all of the others.

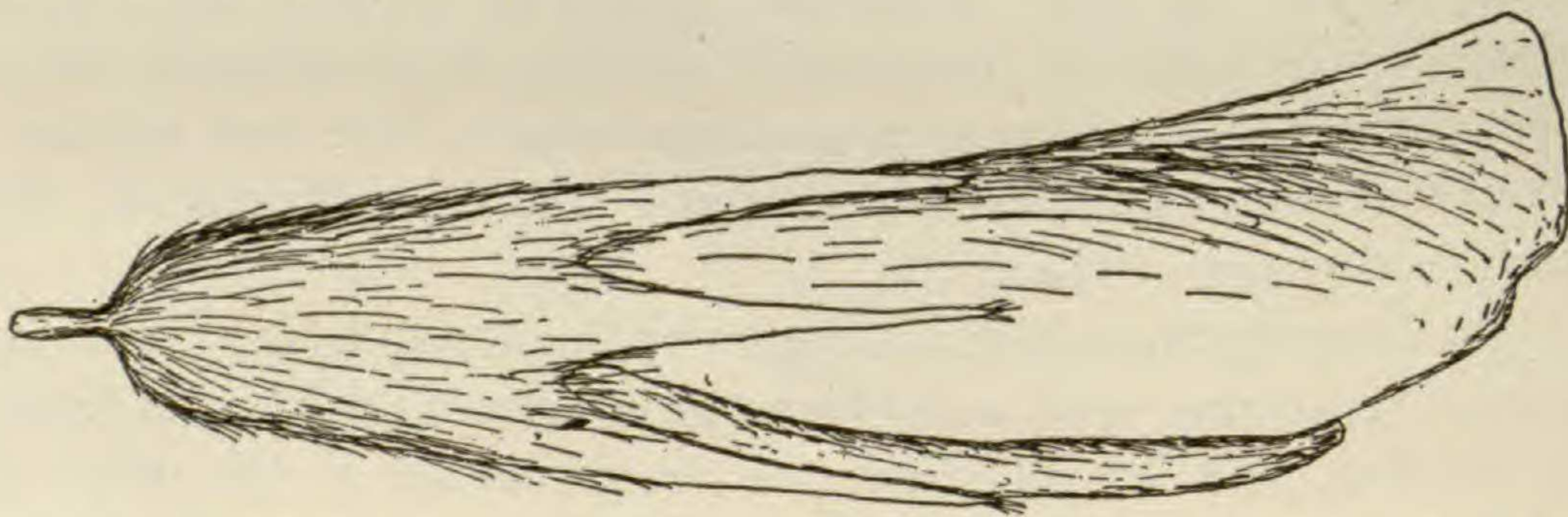


FIG. 2.—Alfalfa bud representing "pointed bud" stage; standard petal is seen to be distinctly curving upward in its growth; lower edges of wing petals, which together fold down over keel, are visible.

stage. This is because all measurements were taken from the base of the calyx to the tip of the flower in the first stages. After the standard began to arise, the measurements continued to be taken to the tip of the interlocking envelope of the wings and keel, which did not further elongate after the erection of the standard. After being measured, each flower was dissected by means of needles and forceps at a magnification of 23 diameters, under a Zeiss binocular microscope, using F-55 objectives and no. 5 oculars. The dissec-

tions were made by removing first the standard, and then one of the wing petals, thus exposing the interior of the flower to view. Care was taken not to set off the tripping mechanism, nor to disturb

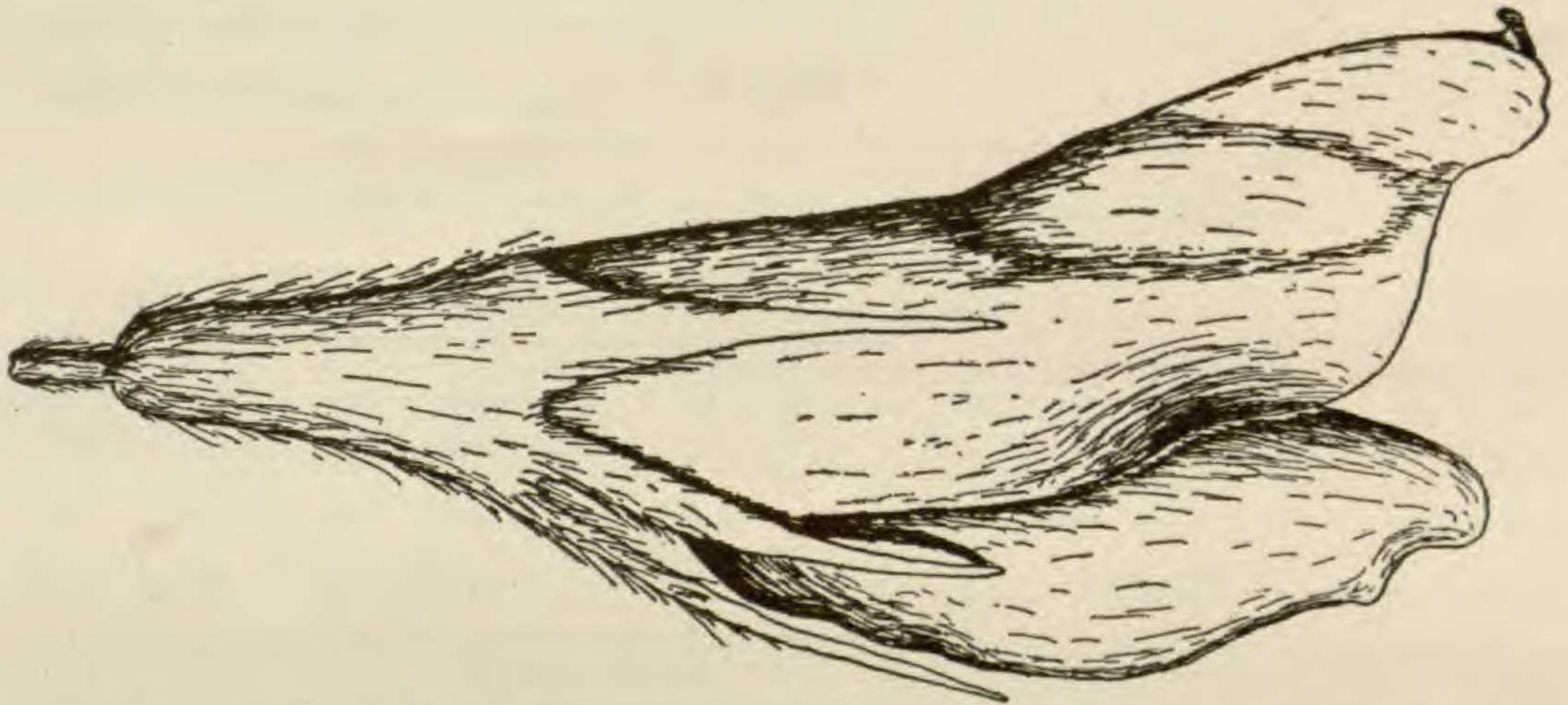


FIG. 3.—Young alfalfa flower called “hooded bud” stage; standard petal has risen nearly to full height, and is beginning to spread; wing petals distinctly seen protruding, folded over keel, which is not yet visible.

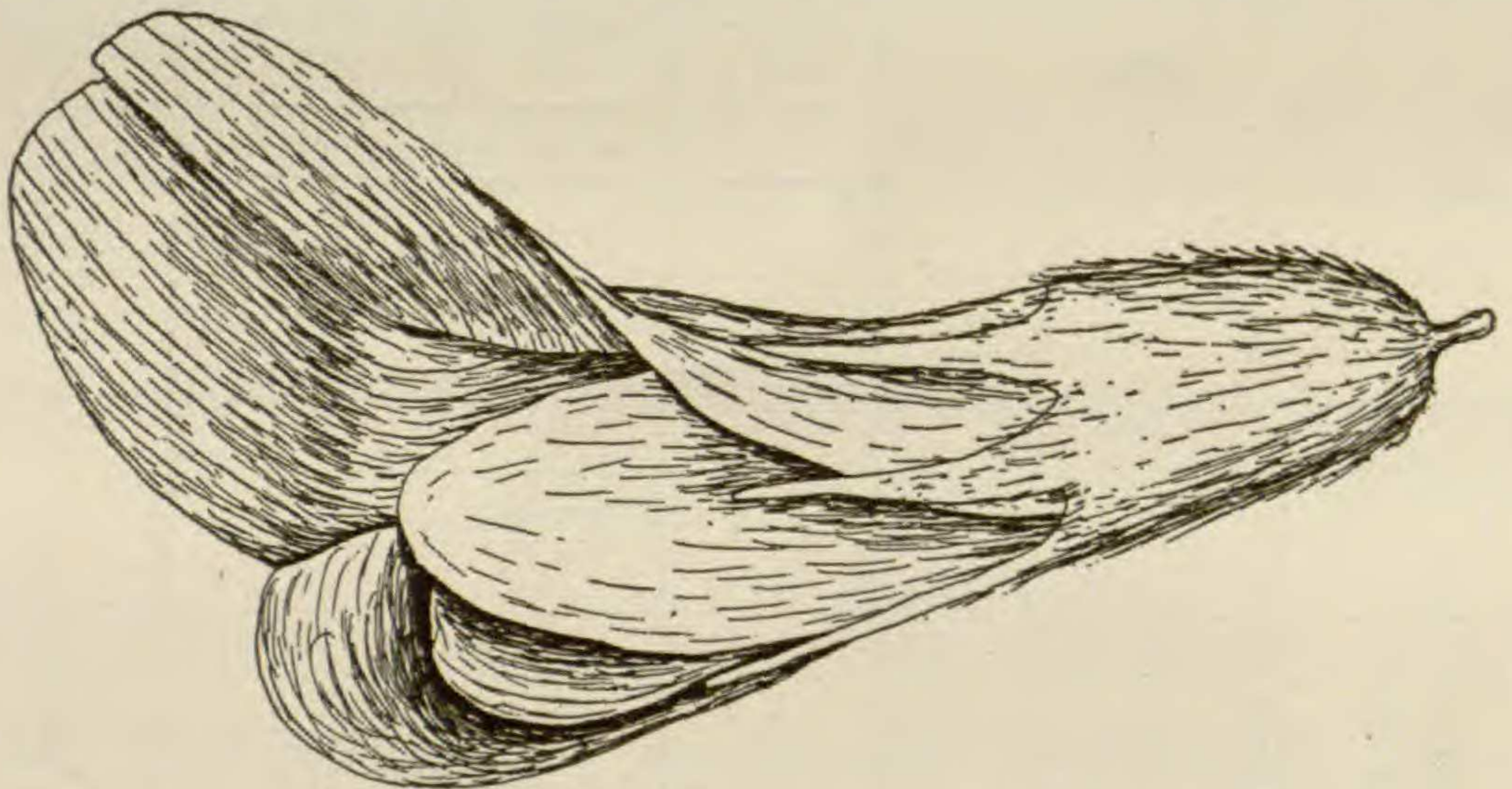


FIG. 4.—Alfalfa flower fully open and ready for tripping, representing “erect standard” stage; standard fully risen and spread; wing petals are separating, showing keel within.

the stamens or otherwise injure the flowers. Flowers believed to have been injured in the dissecting process were discarded and not recorded.

The ratio of buds with anthers dehisced to those with anthers intact, in the pointed bud stage, was surprisingly close. Probably twenty flowers of the straight bud stage, in which the anthers had dehisced, were discarded, since it was thought that they might have

TABLE I

Flower length (mm.)	Anthers intact	Anthers dehisced	Stigmas pollinated
Straight bud stage			
5.....	20	1	1
6.....	49	1	1
7.....	12	1	1
8.....	.....	1	1
Total.....	81	4	4
Pointed bud stage			
6.....	18	1	1
7.....	44	22	19
8.....	21	41	37
9.....	3	19	19
10.....	.....	1	1
Total.....	86	84	77
Hooded bud stage			
7.....	.....	1	1
8.....	.....	8	8
9.....	2	18	18
10.....	1	9	9
Total.....	3	36	36
Erect standard stage			
7.....	.....	1	1
8.....	.....	2	2
9.....	.....	13	13
10.....	.....	4	4
11.....	.....	1	1
12.....	.....	1	1
Total.....	.....	22	22

been injured by dissection, thereby causing the bursting of the anthers. In handling the flowers of the hooded and erect standard stages, care was exercised to prevent them from tripping. The standard was first removed so as to keep the anthers from striking

it and from being broken, should the flower accidentally be tripped. One of the wing petals was then pulled away and the stamens examined. Most of the flowers in the erect standard stage, as they were found in the field, had already been tripped, untripped flowers being rather difficult to secure. A total of 316 flowers was examined and recorded as follows:

Straight bud stage.....	85	Hooded bud stage.....	39
Pointed bud stage.....	170	Erect standard stage.....	22

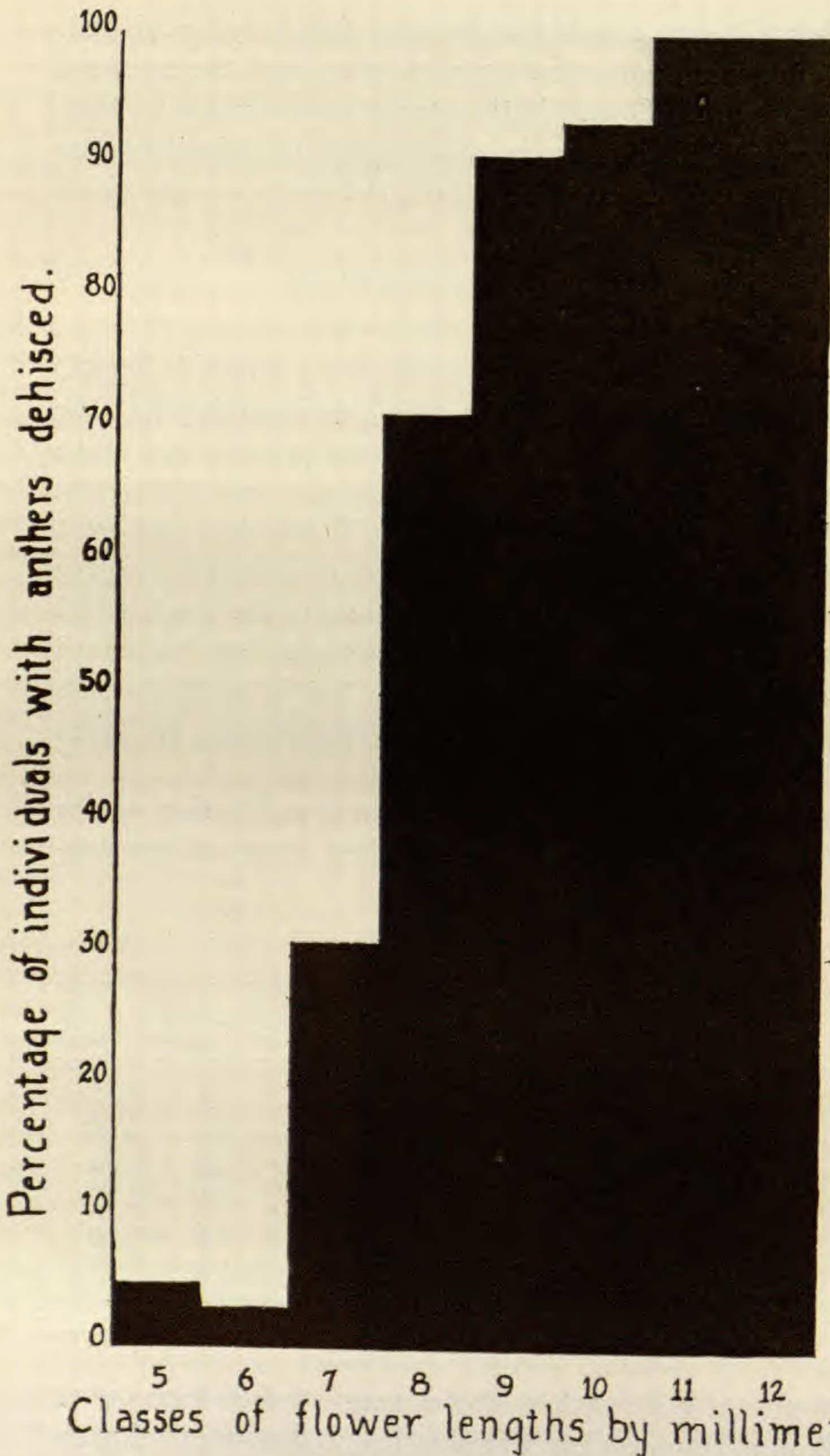
In the straight bud class, the flowers measure 5–8 mm. in length, and of the total number recorded, in only four instances had the stamens shed their pollen. The flowers in the pointed bud stage are considerably longer, being 6–10 mm. in length, and practically one-half of those recorded were pollinated. The hooded and erect classes of buds do not differ greatly from each other in size, varying from 7 to 12 mm. in length. But three flowers in the hooded bud stage had not been pollinated, while no unpollinated erect standard blossoms were found. The data as taken in this investigation, on the stages of bud development in relation to pollination, are given in table I.

From the data secured, the percentages of pollination of the flowers of different lengths, regardless of their stages of development, are given in table II.

TABLE II

Flower length (mm.)	No. examined	No. with anthers intact	Percentage with anthers intact	No. with anthers dehisced	Percentage with anthers dehisced
5.....	21	20	95.24	1	4.76
6.....	69	67	97.11	2	2.89
7.....	81	56	69.14	25	30.86
8.....	73	21	28.77	52	71.23
9.....	55	5	9.09	50	90.91
10.....	15	1	6.67	14	93.33
11.....	1	0	0	1	100.00
12.....	1	0	0	1	100.00
Total....	316	170	.....	146	.....

According to table II, anthers do not seem to shed their pollen before the flowers have reached 7 mm. in length, and most of them have done so by the time they are between 9 and 10 mm. long.



Graph plotted to nearest integers, showing percentage of flowers with anthers dehisced.

Abscissae denote classes of flowers examined, in lengths by millimeters.

Ordinates denote percentage of individuals in each class.

FIG. 5

This relation between dehisced anthers and flower length is shown graphically in fig. 5.

From the data secured as the result of this preliminary investigation, it appears that practically all alfalfa blossoms shed their pollen during the pointed bud stage, and before the hooded bud stage is reached. Judging by this, it would seem that tripping is not essential to pollination.

The alfalfa flower apparently begins to shed its pollen while yet comparatively small, being only about 7 mm. in length, which in hybridization operations would necessitate emasculation being accomplished while the blossom is still in the straight bud stage, in order to eliminate all possible danger of self-fertilization. As a matter of fact, this is a practical impossibility from the mechanical standpoint in the field at least, the flowers being emasculated in alfalfa crossing work by tripping them not earlier than the hooded bud stage and generally later, the pollen then being washed out with an atomizer spray. It is impossible to emasculate the flowers earlier than the hooded bud stage. The writer believes, however, that there is great danger of pollination of the stigma and of consequent self-fertilization, before the time when the flowers are ordinarily tripped in alfalfa by hybridizing operations.

This investigation was carried on in connection with graduate work under the direction of Professor H. F. ROBERTS, of the Department of Botany, Kansas State Agricultural College. The illustrations are from pp. 202-203 of his paper referred to herein.

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